ALIGNMENT OF THE FIRST 7 FRONT-ENDS AT SSRF

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Abstract

Shanghai Synchrotron Radiation Facility, SSRF, is a 3.5 GeV third-generation of synchrotron radiation light source, and for phase Ⅰ there will be 7 beam lines installed. This paper will show the alignment method and survey instrument for the first 7 front-ends at SSRF. Laser tracker and articulated arm are the main tools.

INTRODUCTION

Design of SSRF is 200~300 mA beam current and 3.9nm·rad emittance[1], which is the biggest scientific platform for science research and technology development in China up to now. The maximum capability of SSRF can hold more than 60 beam lines. In phase Ⅰ 7 beam lines and in the near future 8 new beam lines will be installed (Figure 1). For the moment the 7 front-ends have been installed without insertion devices.

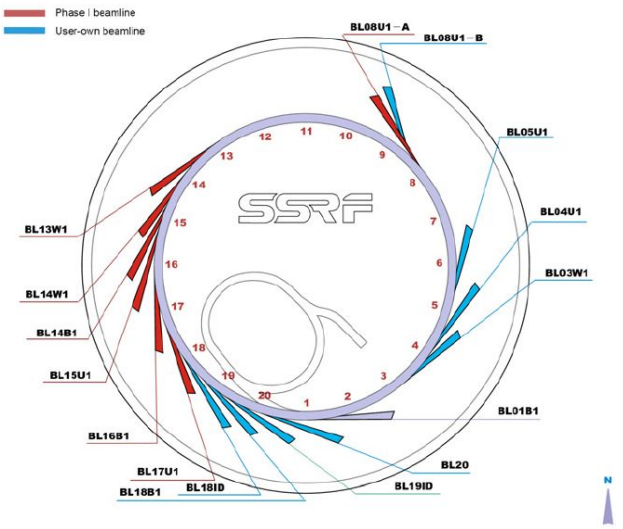

Figure.1: Recent plan of SSRF beam lines.

When doing alignment, fiducialization, pre-alignment, setout, installation in tunnel and realignment were performed, the instruments were used including laser tracker, articulated arm, total station, precision optical Level and jig transit.

The commissioning of storage ring is going on, rather smoothly, and synchrotron radiation light was observed from most of the first fluorescence for the 7 front-ends on 21st January, 2008.

DESIGN OF FRONT-ENDS

Alignment staff participated in the design from the beginning. The front-ends of SSRF based on insertion devices (ID) and bending magnets (BM), which including many components to take roles such as [2]:

- Fixed of the beam size.
- Absorbing of the high heat load.
- Protection of uncooled components and ultra vacuum.
- Shielding the radiation for human safety.
- Monitoring of the photon position.

The two types of front-ends components are similar in the array. Figure 2 shows the layout of front-end components for wiggler.

Because of two beam ports of 1° and 3.1° from BM, alignment transverse space of the front-end is narrow especially and separate supports have to be used. The center component of separate support is photon shutter2 during the pre-alignment process.

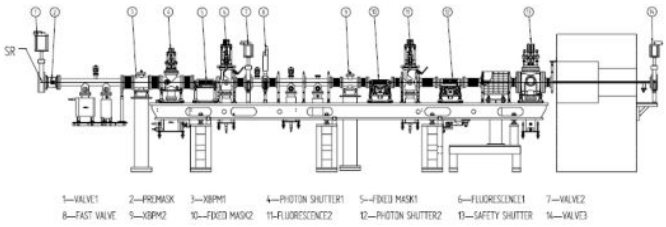

Figure.2:Front-end layout of wiggler

FIDUCIAL MARKS

Fiducial marks are the actual three-dimensional targets that provide a mechanical reference to the effective centreline of the component. Most components such as fixed mask, photon shutter, XBPM, fluorescence, safety shutter have fiducial marks.

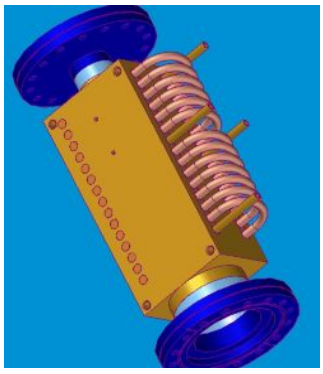

Figure.3: Fiducial marks of fixed mask

At least 4 survey fiducial marks (figure3) are mounted at each component to give facility for easier observation by instrument. The diameter of reference holes are 8mm and an adapter with 8mm shank to hold 1.5″ corner cube reflector of laser tracker or adapter sphere that probe of articulated arm can insert. Cylinders or cubes

(figure 4) with the same holes as mentioned above for fluorescence, photon shutter and safety shutter are jointed to the flange. And reference holes in base planes on top and side of flange are XBPM's fiducial design mode (figure 5).

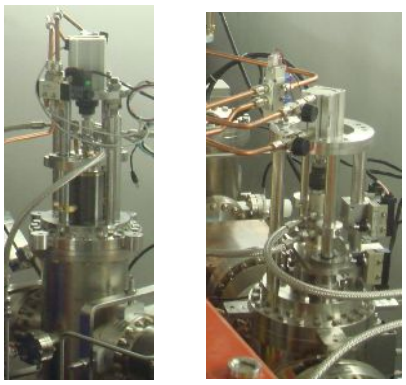

Figure.4: Fiducial marks of fluorescence and photon shutter

Figure.5: Reference holes in flange

FIDUCIALIZATION

The correct fiducialization of components is an important prerequisite to successful alignment. An error in fiducialization will create the same error during final component placement.

Articulated arm is more convenient than laser tracker for small, complicated front-ends' components, it is used to map the reference line, plane and fiducial marks (figure 6). Then a local frame relative to the centerline of components will be defined.

Figure.6: Fiducialization of fixed mask

For reliability, most components should be measured twice with a maximum deviation of 0.05mm. For photo shutter (figure 7), safety shutter and XBPM, whose center planes will be measured and adjusted iteratively as high as the vacuum chamber.

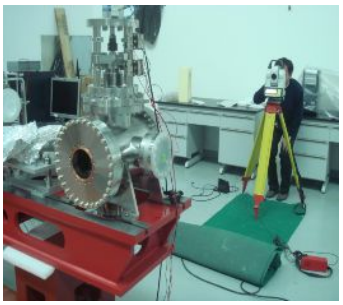

Figure.7: Fiducialization of photo shutter

Some critical shapes and dimensions of the components such as the holes in fixed mask and photo shutter have to be checked by Level N3, total station TDM5005 and Brunson jig transit.

PRE-ALIGNMENT

Due to the tight time schedule and limited accessibility, pre-alignment is done for most front-end components.

Most of the components of ID front-end are mounted on the whole common supports, whose frame is two steel rails. The components' relative coordinates are calculated according to each front-end's layout. Measuring the fiducial marks on components and adjusting them according to theirs reference coordinates within the tolerance of about 0.1mm (figure 8).

Figure.8: Pre-alignment of ID front-end

SETOUT

Laser tracker, LTD500 and its associated software Axyz, was used for setout.

Firstly, the ideal coordinates of the beam lines center and supports were imported into the Axyz software. And the laser tracker was oriented into the tunnel control network by best fitting to several floor and wall control points.

Secondly, create a local frame with the definition: the origin is at light source point, Y is along the beam direction, Z is the vertical direction, and X is ascertained according to right hand rule.

Then, mark the beam axis and the positions for girders' supports within the tolerance of 2 mm (figure 9).

Figure.9: Setout of front-end

INSTALLATION ON SITE & REALIGNMENT

The installation on site including: embedding the anchor bolts, pouring the support and aligning the non-standard girders etc. After pouring, the concrete will be maintained for about a week.

When the supports were ready, co-girder components having been pre-aligned and girders would be craned to tunnel (figure 10).

Figure.10: Crane of front-end

Laser tracker was used for measuring the network of the storage ring and building the frame as the same manner as the setout procedure. Then the components were moved to their ideal nominal positions to within the specified tolerance by using the corresponding capability of the laser tracker software (figure 11).

Figure.11: Installation of front-end

Absolute accuracies of about 0.2mm for key components were expected. Relative to those high precision requirement components, vacuum pipe were aligned within 0.5mm.

All the 7 front-ends were installed smoothly and finished in early Dec 2007. In about one month, vacuum baking procedure was done and high vacuum was gotten. In order to make sure that no big deviation derived from those works, a full re-measurement was performed. Some components were readjusted and all components' final position was confirmed. The procedure was done by laser tracker mostly. But in narrow place, articulated arm was used too.

CONCLUSION

The linac, booster and storage ring all were commissioning smoothly. On 24th December, 2007, beam current was stored with 3GeV and on 3rd Jan, 2008, 100mA beam current was gotten. And synchrotron radiation light was observed from most of the first fluorescence for the 7 front-ends.

During the alignment of the first 7 front-ends, laser tracker and articulated arm were main tools. A real 3D measurement manner was applied for positioning and aligning.

In the near recent months, installation and alignment of the 7 beam lines will started with the same manner by using the control network of experimental hall. Final alignment will be realized by the synchrotron radiation light itself.

ACKNOWLEDGEMENT

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[2] Guanyuan Wu et al. The Design Report of SSRF Front-end, 2006.6.6